

AD-A192 873

THE RELATIONSHIP BETWEEN RADIATION SENSITIVITY AND
REDOX EQUILIBRIA(U) VANDERBILT UNIV NASHVILLE TENN
SCHOOL OF ENGINEERING D L KINSEY ET AL. 01 MAR 68

1/1

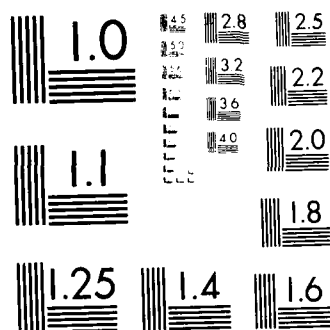
UNCLASSIFIED

ARO-21278. 21-MS DAAG29-84-K-8143

F/G 11/2

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SECURITY CLASS

OTIC

1a REPORT

2a SECURITY

AD-A192 875

DOCUMENTATION PAGE

1b RESTRICTIVE MARKINGS

3 DISTRIBUTION AVAILABILITY OF REPORT

Approved for public release;
distribution unlimited.

2b DECLASSIFICATION/DOWNGRADING SCHEDULE

4 PERFORMING ORGANIZATION REPORT NUMBER(S)

5 MONITORING ORGANIZATION REPORT NUMBER(S)

ARO 21278-21-M5

6a NAME OF PERFORMING ORGANIZATION

6b OFFICE SYMBOL
(if applicable)

7a NAME OF MONITORING ORGANIZATION

Vanderbilt University

U. S. Army Research Office

6c ADDRESS (City, State, and ZIP Code)

7b ADDRESS (City, State, and ZIP Code)

Box 1689, Station B
Nashville, TN 37235P. O. Box 12211
Research Triangle Park, NC 27709-21118a NAME OF FUNDING/SPONSORING
ORGANIZATION8b OFFICE SYMBOL
(if applicable)

9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

U. S. Army Research Office

DAA6-29-84-K-0143

8c ADDRESS (City, State, and ZIP Code)

10 SOURCE OF FUNDING NUMBERS

P. O. Box 12211
Research Triangle Park, NC 27709-2111PROGRAM
ELEMENT NOPROJECT
NOTASK
NOWORK UNIT
ACCESSION NO

11 TITLE (Include Security Classification)

"The Relationship Between Radiation Sensitivity and Redox Equilibria" Unclassified

12 PERSONAL AUTHOR(S)

Donald L. Kinser and Robert A. Weeks

13a. TYPE OF REPORT

13b TIME COVERED

14 DATE OF REPORT (Year, Month, Day)

15 PAGE COUNT

Final

FROM 8-1-84 TO 10-31-84

1988, March, 1

5

16 SUPPLEMENTARY NOTATION

The view, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

17 COSATI CODES

18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)

FIELD

GROUP

SUB-GROUP

Class, processing radiation defects

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

This program examined the role of glass processing upon subsequent radiation effects with particular focus upon optical absorption centers. The results have indicated a number of strategies appropriate for the mitigation of radiation induced darkening of optical components. The fundamental understanding of the relationship between glass processing variables and atomic defects in glasses has permitted these advances.

DTIC

ELECTE

APR 13 1988

D

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT

21 ABSTRACT SECURITY CLASSIFICATION

☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS

Unclassified

22a NAME OF RESPONSIBLE INDIVIDUAL

22b TELEPHONE (Include Area Code)

22c OFFICE SYMBOL

THE RELATIONSHIP BETWEEN
RADIATION SENSITIVITY AND REDOX EQUILIBRIA

Final Report

Submitted by:

Donald L. Kinser
and
Robert A. Weeks

Co-Principle Investigators
Materials Science and Engineering
School of Engineering
Vanderbilt University
Nashville, TN 37235

March 1, 1988

Submitted to:

U. S. Army Research Office

Proposal Number:
P-21278-MS
Contract Number:
DAAG-29-84-K-0143

Vanderbilt University

Approval For	
NTIS CRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution	
Availability Codes	
Date	Copy Number
A-1	1
<div style="border: 1px solid black; border-radius: 50%; padding: 5px; text-align: center;"> FILE COPY INSPECTED 4 </div>	

Approved for Public Release;
Distribution Unlimited

The view, opinions, and/or findings contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

Abstract:

This program examined the role of glass processing upon subsequent radiation effects with particular focus upon optical absorption centers. The results have indicated a number of strategies appropriate for the mitigation of radiation induced darkening of optical components. The fundamental understanding of the relationship between glass processing variables and atomic defects in glasses has permitted these advances.

Statement of Research Problem:

The work conducted under this program has focused upon the role of glass processing upon the defect concentrations in as-prepared glasses of various types. The subsequent interaction of those defects with ionizing radiation has also been monitored using experimental techniques such as electron paramagnetic resonance (EPR), DC conductivity, optical absorption, and optical bleaching. A number of these studies have also included annealing studies of the defects so as to ascertain the thermal stability of the various defects in the irradiated glasses.

Overview of Results Obtained:

The bulk of the results obtained on this program have been reported in the published literature in the 21 papers published to date. At least one additional paper is anticipated as a result of the work conducted under this program.

The results of this program have outlined the salient variables involved in the melting of a glass as they influence the atomic defect population of the resulting glass. Such processing variables include the melting atmosphere, temperature, quenching rate and subsequent annealing processes. It has become clear that atomic defects of two types arise in glasses. The first of these defects is the chemical defect such as non-stoichiometry or an impurity atom in the glass. The missing atom (nonstoichiometry) or an atom of the wrong valence (impurity atom) each result in an associated defect which is a site for electron trapping in subsequent ionizing radiation environments. This is one source of radiation induced damage which can be mitigated by processing to avoid nonstoichiometry or impurity atoms.

The second class of atomic defect is associated with disorder in the glass. This can be exemplified by an oxygen atom which is ordinarily two coordinated or connected to two silicon atoms. If an oxygen is triply coordinated or singly coordinated, a local disorder arises. This defect is a simple consequence of structural disorder at a particular atom site. A classic example of such a defect is the intimate valence alternation pair (IVAP) first hypothesized in chalcogenide glasses but observed in SiO_2 during the course of this research.

Publications Resulting from this Research:

1. "Effects of Densification Conditions on the Defect Center Concentration in Germanium-Doped Silica Optical Fiber Preforms", Journal of Non-Crystalline Solids, 69 January 1985, pgs. 293-298, G. Kordas, D. L. Kinser, and R. A. Weeks.
2. "The Effect of Melt Temperature on the DC Conductivity of GeO_2 Glasses," Journal of Applied Physics, 57, (2), January 1985, pp. 345-350, R. Magruder, R. Weeks, J. Jackson, and D. L. Kinser.
3. "Fusion Temperature Effects on the Annealing Behavior of GeO_2 Glasses as Measured by the DC Resistivity", Journal of Non-Cryst. Solids, Vol. 71, May 1985, pp.95 - 102, R. Magruder, III, D. L. Kinser, and R. Weeks.
4. "Paramagnetic Conduction Electrons in Germanium Sulfide Glasses," Journal of Non-Crystalline Solids, Vol. 71, May 1985 pp. 157-161, G. Kordas, D. L. Kinser, and R. Weeks.
5. "Sol-Gel Glasses by Non-Aqueous Processes", Journal of Non-Cryst. Solids, Vol. 71, May 1985, pp. 361-371, F. Bonner, D. L. Kinser, and G. Kordas.
6. "Electron-Spin-Resonance (ESR) Study of Sol-Gel Glasses", Journal of Non-Cryst. Solids, Vol 71 (1985) 327-333, G. Kordas, R. A. Weeks and L. Klein.
7. "Preparation Effects on the UV Optical Properties of GeO_2 Glasses", Journal of Applied Physics, Vol. 58, No. 6, Sept., 1985, pp. 2308-2311, J. Jackson, M. Wells, R. Magruder, III, G. Kordas, R. Weeks, and D. L. Kinser.
8. "Dependence of Sodium Ion Mobility upon Melt Atmosphere in GeO_2 Glasses", Communications of the American Ceramic Society, January 1986, Vol. 69, No.1, C10 & C11, R.H. Magruder, III, D. L. Kinser, and R. A. Weeks.
9. "The Effects of Annealing of the GeO_2 Glasses on their Paramagnetic Center Concentration" G. Kordas and R. Weeks, Collected Papers, XIV International Congress on Glass, (1986) pp 17-23.
10. "The Effects of Heat Treatments on the Magnetic and Optical Properties of Fe Ions Implanted in SiO_2 Glass" R. A. Weeks, Glenn Whichard, George Kordas and B. R. Appleton, Collected Papers, XIV International Congress on Glass, 1986 pgs 236-243.
11. "The Nature of the Paramagnetic States in SiO_2 - GeO_2 Sol-Gel Glasses" G. Kordas and S. P. Mukherjee, Materials Research Symposia 61 (1986) pgs 413-417.

12. "The Structure of SiO_2 -Sol-Gel Glasses Produced from Gels with Various Mole-Water per Mole-TEOS Ratios" G. Kordas" Materials Research Symposia 61 (1986) 419-423.
13. "Ion Transport as a Technique for Studying Glass Structure," Proceedings of the XIV International Congress on Glass, New Delhi, India, March 1986, Vol.I, pp. 24-31, D. L. Kinser, R. H. Magruder, III, Bipradas Dutta, and John M. Jackson.
14. "Experimental Evidence for the Existence of Intimate Valence Alternation Pair Defects in GeO_2 Glasses," Proceedings of VIth International Conference on The Physics of Non-Crystalline Solids, July 6-10, 1987, Kyoto, Japan, J. Non-Cryst. Solids, 95, 389-396 (1987), B. Dutta, R. Magruder, D. L. Kinser, and R. Weeks.
15. "Raman Studies of GeO_2 Glass Preparation History," Journal of Non-Crystalline Solids, 94, 56-61 (1987), R. Magruder, III, Steve Morgan, R. A. Weeks and D. L. Kinser.
16. "Computerized Apparatus for Thermally Stimulated Current (TSC) Measurements", Review of Scientific Instruments, June, 1987, pp. 1003-1008, J. M. Jackson, D. L. Kinser and Bipradas Dutta.
17. "Optical Properties of GeO_2 ," Physical Review B, Vol. 36, No. 11, October 15, 1987, pp. 6132-6134, N. M. Ravindra, D. L. Kinser, and R. A. Weeks.
18. "Effects of Liquid Equilibration Temperature, T_ϕ , on the Properties of Germania Glass: A Review," to be published in Proceedings of the 2nd International Conference on Effects of Modes of Formation on the Structure of Glass with R. A. Weeks.
19. "Microstructural Studies of Colloidal Silica Derived Aerogels" Ronald Alan Quarles MS Thesis, Vanderbilt University, December. 1986
20. "Thermal Analysis of the Radiation Induced Conductivity in GeO_2 Glasses," submitted to Journal of Non-Crystalline Solids, December 1987, R.H. Magruder, D. L. Kinser, R.A. Weeks, J.M. Jackson and E. Sonder.
21. "Electrical Conduction and Polarization in Lead Silicate Glasses," submitted to Journal of American Ceramic Society, December 1987, B. Dutta, D.L. Kinser, R. H. Magruder, and R.A. Weeks.

Personnel Supported by Program:

1. Co-Principal Investigator: D. L. Kinser
2. Co-Principal Investigator: R. A. Weeks
3. Faculty Associate: G. Kordas
4. Faculty Associate: N. M. Ravindra
5. Graduate Student: Bipradas Dutta - PhD Completed 8/87
6. Graduate Student: Ronald A. Quarles - MS Completed 12/86
7. Graduate Student: John M. Jackson
8. Undergraduate Student: John Montgomery - BS Completed 12/87

END

DATE

FILMED

6-1988

DTIC